[SPECIFICATION]

[Title of the Invention]

DISCHARGING METHOD OF LIQUID CRYSTAL DISPLAY DEVCIE AND METHOD OF FABRICATING IN PLANE SWITCHING MODE LIQUID CRYSTAL DISPLAY DEVICE

[Brief description of the Drawings]

Figure 1 is a plan view showing a in-plane switching mode LCD device in accordance with the related art.

Figures 2a to 2e are processing views showing a fabricating method of a in-plane switching mode LCD device in accordance with the conventional art.

Figure 3 is a sectional view showing a normal driving of an liquid crystal display device.

Figure 4 is a sectional view showing an abnormal driving of an liquid crystal display device due to a back surface charge of a thin film transistor in accordance with the conventional art.

Figure 5 is a processing flow chart of a general liquid crystal display device according to the present invention.

Figure 6 is a layout showing a grinding process and a test process.

Figure 7 shows a driving principle of an ionizer.

Figure 8 shows a discharging principle of a charged object.

**** Explanation for the major reference numerals ****

101 : cleaning unit 103 : buffer

105 : discharging device
107 : robot
110 : input table
111 : output table
113 : lighting test unit
115 : supply table
200 : probe

[Detailed description of the invention]

[Object of the invention]

[Field of the invention and background art]

The present invention relates to a liquid crystal display device, and more particularly, to a discharging method of a in-plane switching mode liquid crystal display panel for removing stain due to static electricity generated in processing the liquid crystal display panel.

Generally, a twisted nematic mode liquid crystal display (LCD) device mainly used as a flat panel display device of high picture quality and low electric power has a narrow viewing angle. This results from a refractive anisotropy of liquid crystal molecules, and the reason is because the liquid crystal molecules aligned horizontally with a substrate is aligned vertically with the substrate when a voltage is applied to a liquid crystal display panel.

Accordingly, an in-plane switching mode liquid crystal display device for solving the viewing angle problem by aligning the liquid crystal molecules horizontally with the substrate is being researched actively.

Figure 1 is an in-plane switching mode LCD device in accordance with the related art.

As shown in the drawing, a gate line 1 and a data line 2 are arranged horizontally and vertically on a transparent substrate to define a pixel region. In an actual liquid crystal

display device, N gate lines 1 and M data lines 2 are crossed to define pixels of N x M. However, in the drawing, only one pixel is shown for a simple explanation. A thin film transistor T is arranged at a crossing section of the gate line 1 and the data line 2, and a common line 3 parallel to the gate line 1 is arranged in the pixel region. Also, at least a pair of electrodes, that is, a pixel electrode 8 and a common electrode 9 for switching the liquid crystal molecules by being arranged parallel to each other are formed in the pixel. The pixel electrode 8 is connected to a drain electrode 6b of the thin film transistor T and the common electrode 9 is connected to the common line 3, so that a voltage is applied from outside through the thin film transistor T to generate a lateral electric field between the pixel electrode 8 and the common electrode 9.

Figures 2a to 2e are processing order views showing a fabricating method of a in-plane switching mode LCD device in accordance with the related art.

First of all, as shown in Figure 2a, a first metal layer is deposited on a first transparent substrate 10 by a sputtering method and photo-etched thus to form a gate electrode 5 and the common electrode 9.

Then, as shown in Figure 2b, SiOx or SiNx, amorphous silicon (a-Si), and impurity amorphous silicon (n+ a-Si) are deposited thus to form a gate insulating layer 12, a-Si layer 15a, and n+ layer 16a. Then, as shown in Figure 2c, the a-Si layer 15a and the n+ layer 16a are patterned thus to form a semiconductor layer 15 and an ohmic contact layer 16.

Thereafter, as shown in Figure 2d, a second metal layer is deposited and patterned thus to form a source electrode 6a, the drain electrode 6b, and the pixel electrode 8. Then, a passivation film 20 is formed thereon entirely, and the passivation film 20 in the pixel region is removed in order to strengthen an intensity of the lateral field applied between the common electrode 9 and the pixel electrode 8.

Then, as shown in Figure 2e, a first alignment film 23a is deposited on the entire substrate, and an alignment process is performed on the first alignment film 23a thus to fabricate a thin film transistor substrate 40. Also, a black matrix 28 for preventing light from being leaked to the thin film transistor T, the gate line, and the data line is formed on a second transparent substrate 12. Then, a color filter layer 29 is formed thereon, and a second alignment film 23b is deposited on the entire substrate thus to fabricate a color filter substrate 50. Thereafter, a liquid crystal is injected between the thin film transistor substrate 40 and the color filter substrate 50 thus to form a liquid crystal layer 30.

When the device is completed by said processes, an electric test is performed to detect opening and shorting of lines. At this time, a partial charge is generated on the substrate by frequent movements of the liquid crystal display panel attached by the thin film transistor substrate and the color filter substrate.

Especially, if a charged region is generated at the thin film transistor substrate, the liquid crystal is not driven well in the charged region at the time of an automatic lighting test thus to generate stain on a image. The stain is called as electrostatic stain.

More specifically speaking, in case of an liquid crystal display device normally driven due to no charged region, as shown in Figure 3, if a voltage is applied between the pixel electrode 8 and the common electrode 9, a lateral field having a constant direction therebetween is generated. At this time, the liquid crystal is twisted towards the field direction according to an intensity of the applied voltage.

However, in case that a partial charge is generated at the back surface of the thin film transistor substrate by frequent movements of the substrate at the time of processing, as shown in Figure 4, the charged region 32 distorts the electric field between the pixel electrode 8 and the common electrode 9. Accordingly, the liquid crystal aligned at the part is not normally driven but generates stain on the image at the time of lighting. That is, the

lighting test is performed in a state that the charging of the liquid crystal display panel is not removed completely, so that a picture quality is greatly influenced at the time of the lighting test thus not to enable a correct defect detection of the liquid crystal display panel.

[Problem to be solved by the invention]

Therefore, an object of the present invention is to provide a method for discharging a in-plane switching mode liquid crystal display panel which can prevent electrostatic stain at the time of a lighting test.

[Construction of the invention]

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a method for discharging a in-plane switching mode liquid crystal display panel including: preparing a color filter substrate and a thin film transistor substrate; forming a liquid crystal layer between the color filter substrate and the thin film transistor substrate thus to form a liquid crystal display panel; and discharging at least one surface of the liquid crystal display panel.

In another aspect of the present invention, there is provided a method for discharging a in-plane switching mode liquid crystal display panel including: forming a color filter substrate and a thin film transistor substrate; forming a liquid crystal layer between the color filter substrate and the thin film transistor substrate thus to form a liquid crystal display panel; discharging the thin film transistor substrate of the liquid crystal display panel; and performing a lighting test for the liquid crystal display panel.

In another aspect of the present invention, there is provided a method for discharging a in-plane switching mode liquid crystal display panel including: forming a

color filter substrate and a thin film transistor substrate; forming a liquid crystal layer between the color filter substrate and the thin film transistor substrate thus to form a liquid crystal display panel; simultaneously discharging the color filter substrate and the thin film transistor substrate of the liquid crystal display panel; and performing a lighting test for the liquid crystal display panel.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

A fabrication process of an in-plane switching mode liquid crystal display panel is shown in Figure 5.

First of all, a thin film transistor substrate on which a plurality of thin film transistors are formed, and a color filter substrate on which a color filter is formed are provided (S11, S12). At this time, a fabrication process of the thin film transistor substrate is shown in Figures 2A to 2E.

Then, forming an alignment film on the thin film transistor substrate and the color filter substrate (S13, S14). Processes for forming the alignment film include a process for applying a thin film of polymer and a rubbing process. The thin film of high polymer is generally called as the alignment film. The alignment film has to be applied to the entire thin film transistor substrate uniformly, and the rubbing has to be also uniform.

The rubbing process is a main process which determines an initial arrangement direction of a liquid crystal, and liquid crystal molecules are aligned by the rubbing direction. Accordingly, when the alignment film and the rubbing are performed uniformly, the liquid crystal molecules are uniformly aligned and thus the liquid crystal display device

has uniform display characteristics.

Thereafter, a spacer is dispersed on the thin film transistor substrate on which the alignment film is formed, and a seal pattern is formed on the thin film transistor substrate or the color filter substrate (S15, S16).

The seal pattern is to form a gap for a liquid crystal injection and to prevent the injected liquid crystal from being leaked. Generally, the seal pattern is completed by forming thermosetting resin as a desired pattern constantly by a screen printing method.

When the spacer process and the seal pattern process are completed, the color filter substrate having a printed color filter, and the thin film transistor substrate on which a thin film transistor, a pixel electrode, and a common electrode are arranged are attached to each other (S17).

The attachment of the thin film transistor substrate and the color filter substrate is determined by a margin given at the time of designing each substrate, in which minuteness corresponding to several m is required. If the two substrates are attached by exceeding an error range, light is leaked thus not to have a desired picture quality at the time of driving a liquid crystal cell.

Then, the liquid crystal display panel fabricated by said processes is cut into unit panels.

The cutting process includes a scribe process for forming a crack on the substrate by using a wheel of diamond material having greater hardness than a glass substrate; and a break process for cutting the substrate on which the crack is formed by applying force.

Then, injecting a liquid crystal into an liquid crystal injection opening of the liquid crystal display panel which is cut into unit panels thus to complete a panel (S19). Next, a grinding process for removing a shorting bar additionally formed at an outer periphery of a pad portion to prevent electrostatic generation among lines in the middle of

processing is performed (S20).

Thereafter, a test for inspecting defect of the fabricated unit panels is performed (S21). Herein, an operation of the thin film transistor and a pixel lighting are tested.

In the present invention, the grinding process and the test process are performed by an in-line method, and an ionizer for removing electrostatic is provided at a position where each liquid crystal display panel is located.

The inonizer is installed to remove electrostatic generated by frequent movements of the panel or by a contact with a panel carrier (for example, a robot arm). The ionizer is provided at the lower portion of the thin film transistor substrate in order to discharge intensively, thereby preventing electrostatic generated from charge of the thin film transistor.

In case of a TN(twisted nematic) mode, even if the thin film transistor substrate is charged, a picture quality is not greatly influenced at the time of lighting. However, in the plane switching mode liquid crystal display device, the pixel electrode and the common electrode are all formed on the thin film transistor substrate and a liquid crystal is driven by an electric field therebetween. Accordingly, if the back surface of the thin film transistor substrate is charged, the charged region influences on the electric field between the pixel electrode and the common electrode. Therefore, a liquid crystal is not operated well in the region and stain is generated at a image at the time of lighting. Like this, stain for causing electrostatic is called as electrostatic stain.

Accordingly, the present invention is to provide a method for discharging a thin film transistor substrate effectively.

Hereinafter, the present invention will be explained in more detail with reference to the attached drawings.

Figure 6 is a plan view showing a layout of a test step after the liquid crystal

injection and the scribe/break process.

As shown, a cleaning unit 101 for cleaning impurities generated at the time of the grinding process and a lighting test unit 113 for testing a lighting are arranged as a series, and a robot 107 for transferring the liquid crystal display panel at a desired position is arranged.

Also, arranged are a buffer 103 for storing the cleaned liquid crystal display panel before the lighting test; a supply table 115 for supplying the panel to the lighting test unit 113; an input table 110 installed between the buffer 103 and the supply table 115; and an output table 111 for transferring the tested panel to a next process and a movable table 117.

A discharging device 105 is provided at the cleaning unit 101, the buffer 103, the input table 110, and the supply table 115. The discharging device 105 removes electrostatic generated at a surface of the substrate by a minute friction at the time of transferring the panel.

The discharging device 105 is to discharge a charged region generated at the liquid crystal display panel at the time of processing, particularly to discharge the back surface of the thin film transistor substrate. Also, a discharging device 105 having a discharging direction from an upper direction to a lower direction and for discharging the color filter substrate is installed at least one of the cleaning unit, the buffer, the input table, and the supply table.

The discharging device such as the ionizer discharges by a discharging principle shown in Figure 7. That is, if N_2 gas is supplied to the ionizer having plural probes 200, the ionizer continuously generates negative ions (N_2 -) and positive ions (N_2 +) per a constant time interval (1/60 second) through the probes 200. At this time, since the negative ions and the positive ions have the same amount externally, the entire state is neutral. Also, in case of a charged object, the charged object is neutralized by an attractive force or a

repulsive force between a polarity of the charged object and the positive/negative ions generated from the probes.

The discharging principle will be explained in more detail with reference to Figure 8. In case of the substrate 150 which is partially charged with positive ions, the positive ions generated from the probe 200 do not move, but the negative ions move to the charged substrate by the attractive force. At this time, the negative ions are attracted by the attractive force and the positive ions charged on the substrate are neutralized thus to remove electrostatic.

Electrostatic generated at the thin film transistor substrate or the color filter substrate is removed by said discharging principle. Especially, the present invention intensively discharges the thin film transistor substrate where the common electrode and the pixel electrode are formed, so that a distortion generated between the common electrode and the pixel electrode can be prevented and thus electrostatic stain generated at the charged region of the back surface of the thin film transistor substrate can be removed.

[Effect of the invention]

As aforementioned, the present invention discharges the back surface of the thin film transistor substrate intensively at the time of processing the liquid crystal display panel, so that a driving inferiority of the liquid crystal due to the charge of the thin film transistor substrate is prevented thus to remove electrostatic stain displayed on the screen at the time of the lighting test.

Also, since the electrostatic stain of the image due to the charge of the back surface of the thin film transistor substrate is removed at the time of the lighting test, defect inspection of the liquid crystal display panel is facilitated thus to increase productivity.